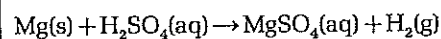


## 8.5 Measuring reaction rates

Magnesium reacts with dilute hydrochloric acid to produce magnesium sulphate and hydrogen.



The rate of this reaction can be investigated by measuring, at regular intervals, the volume of hydrogen collected.

The average rate of reaction is given by:

$$\text{average rate} = \frac{\text{total volume of hydrogen collected}}{\text{time taken to collect the hydrogen}}$$

The rate of reaction continually changes during the reaction. At a given instant, the rate of reaction can be determined from the slope of the graph (volume against time) at that instant.

### Aim

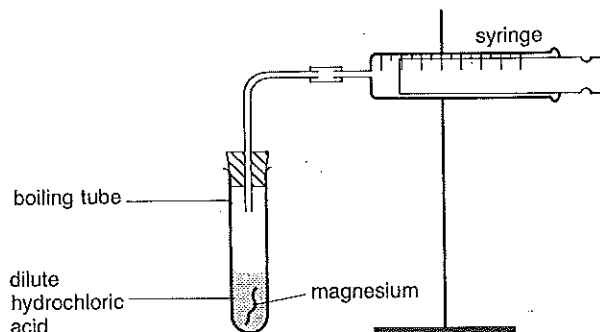
To measure the rate at which hydrogen gas is given off in the reaction between magnesium and dilute hydrochloric acid.

### Apparatus and materials

Boiling tube with bung and delivery tube  
Gas syringe, 100 cm<sup>3</sup>  
Stand, boss and clamp, or syringe holder  
Stopclock or timer  
Measuring cylinder, 10 cm<sup>3</sup>  
Emery paper  
Magnesium ribbon, 4 cm  
Dilute hydrochloric acid, 1 mol dm<sup>-3</sup>

### Procedure

- 1 Clean a 4 cm length of magnesium ribbon by pulling it through emery paper.
- 2 Use the measuring cylinder to pour 10 cm<sup>3</sup> of dilute hydrochloric acid into the boiling tube.
- 3 Tilt the boiling tube and balance the magnesium ribbon on the upper part. Connect the boiling tube to the gas syringe.
- 4 Adjust the reading on the gas syringe to zero.
- 5 Drop the magnesium ribbon into the acid and start the timer.
- 6 As the hydrogen gas is given off gently rotate the plunger of the gas syringe.
- 7 Read the volume of gas in the gas syringe every ten seconds until the volume remains constant.



### Results

Copy and complete the following table.

time/s	0	10	20	30	40	50	60	70	80	90	100
volume of hydrogen/cm <sup>3</sup>											

Plot a graph of volume of gas in cm<sup>3</sup> (vertical axis) against time in seconds (horizontal axis).

### Extra work

- Carry out two further experiments using the same mass of magnesium turnings and then magnesium powder. Plot two graphs as before.
- Repeat the experiment using zinc foil or granules.
- Repeat the experiment with zinc granules and a few drops of copper(II) sulphate solution.

### Questions

- 1 a) Why must the plunger of the gas syringe be rotated?  
b) In this experiment both air and hydrogen are collected in the gas syringe rather than just hydrogen. Why does this have no effect on your results?  
c) If no gas is collected in the gas syringe what might be the problem, and how would you solve it?  
d) What would happen if magnesium powder were used rather than ribbon?  
e) Explain the shape of the graph you have obtained.
- 2 Calculate the average rate of reaction from your experimental results.
- 3 Using the graph of your experimental results draw tangents to the curve at each 10 second interval. Use the tangents to calculate the rate of reaction every 10 seconds.